AMENDMENTS TO THE DRAWINGS

In response to the drawing objection, two new drawing sheets (Figs. 6-7) are submitted herewith to show the feature of "the well layer containing a thick portion having a large thickness and a thin portion having a small thickness" as claimed in claim 1.

Attachment: Two New Drawing Sheets (Fig. 6 and Fig. 7)

REMARKS

Upon entry of the present Amendment, claims 1-2 and 5-19 will be all the claims pending in the application. Claims 1 has been amended. Claims 3-4 have been canceled without prejudice. Claims 18-19 have been added.

Claim 1 has been amended to further clearly point out the claimed subject matter. Claim 1 has been amended to incorporate therein the subject matter of claims 3 and 4, to recite a light-emitting layer of a quantum well structure that is formed of a gallium nitride compound semiconductor barrier layer doped with an impurity element and a gallium nitride compound semiconductor well layer undoped with any impurity element, the light-emitting layer being provided on a second side of the crystalline substrate.

New claim 18 depends from claim 1. Claim 18 recites a gallium nitride compound semiconductor light-emitting device according to claim 1, wherein the barrier layer is a barrier layer which is doped with a Group IV element at an average atom density of 1×10^{17} cm^{-3} to 5×10^{18} cm^{-3} and which exhibits low resistance. Support for claim 18 can be found in the specification, for example, at page 17, lines 18-22.

New claim 19 depends from claim 1. Claim 19 recites a gallium nitride compound semiconductor light-emitting device according to claim 1, wherein the barrier layer is an Si-doped n-type GaN barrier layer. Support for claim 19 can be found in the specification, for example, at page 17, lines 23-28.

Entry of the Amendments is respectfully requested.

I. Drawings Objection

In response to the drawing objection, two new drawing sheets (Figs. 6-7) are submitted herewith to show the feature of "the well layer containing a thick portion having a large thickness and a thin portion having a small thickness" as claimed in claim 1. No new matter has been added.

Specifically, Fig. 6 is a cross-sectional TEM micrograph of a light-emitting layer, in which reference numerals 31 and 32 denote, respectively, well layers and barrier layers constituting the light-emitting layer, numerals 31A, 31B and 31C denote thin portions of the well layers and numerals 31E, 31F and 31G denote thick portions of the well layers. In addition, reference numerals 2(16) and 4(14) denote a p-AlGaN cladding layer and an n-InGaN cladding layer, respectively.

Fig. 7 is based on Fig. 2, and shows the light-emitting layer 3 (15) in detail. The given reference numerals correspond to those shown in Fig. 2, respectively, and the parenthesized reference numerals correspond to those shown in Fig. 5, respectively. Reference symbols D and T denote the width and thickness, respectively, of the thick portion 31E of the well layer 31.

Withdrawal of the objection and acceptance of the new drawing sheets are respectfully requested.

II. Response to Claim Rejections under 35 U.S.C. § 102 (b) & 103(a) over Yamada

Claims 1-2, 5, 11 and 16-17 were rejected under 35 U.S.C. 102(b) as allegedly being anticipated by Yamada (US 6,608,330 B1).

Claims 6-8 were rejected under 35 U.S.C. 103(a) as being unpatentable over Yamada in view of Hanaoka et al. (US 5,804,839).

Claim 9 was rejected under 35 U.S.C. 103(a) as being unpatentable over Yamada.

Claims 12, 13 and 15 were rejected under 35 U.S.C. 103(a) as being unpatentable over Yamada in view of Morita et al. (US 6,121,636).

Claim 14 was rejected under 35 U.S.C. 103(a) as being unpatentable over Yamada in view of Kaneyama et al. (US 6,452,214 B2).

Applicants respectfully traverse the above rejections.

Claim 1 presently recites a light-emitting layer of a quantum well structure that is formed of a gallium nitride compound semiconductor barrier layer doped with an impurity element and a gallium nitride compound semiconductor well layer undoped with any impurity element, the light-emitting layer being provided on a second side of the crystalline substrate.

Yamada was cited as disclosing a gallium nitride compound semiconductor light-emitting device (e.g., Figure 1) comprising a crystalline substrate (substrate 101); a light-emitting quantum well structure (active layer 106) which is formed of a gallium nitride compound semiconductor barrier layer (layers 107) and a gallium nitride compound semiconductor well layer (layers 108 and 109), which light-emitting layer is provided on a second side of the crystalline substrate (e.g., as seen in Figure 1); a contact layer formed of a Group III-V compound semiconductor for providing an Ohmic electrode for supplying device operation current to the light-emitting layer (layer 111, formed from GaN as stated in col. 8, line 41); and an Ohmic electrode (electrode 112)) which is provided on the contact layer (e.g., as seen in Figure 1) and has an aperture through which a portion of the contact layer is exposed (e.g., as seen in Figure 1, the sides of electrode 112 are open, exposing the contact layer 111), wherein the Ohmic electrode exhibits light permeability with respect to

light emitted from the light-emitting layer (col. 10, line 42 discloses electrode 112 as being transparent), and the well layer contains a thick portion having a large thickness and a thin portion having a small thickness (e.g., col. 13, lines 16-36, with reference to Figure 6, disclose that the well layers have both thin and thick regions).

Yamada also discloses that: "[I]t is noted that the well layers 108 and 109 may be undoped or doped with the acceptor impurity such as Mg and Zn, or with the donor impurity such as Si. Further the well layers 108 and 109 may be doped with both of the acceptor and donor impurity." Col. 10, lines 3-7.

However, Yamada fails to disclose that only the barrier layer is doped with an impurity component, as recited in present claim 1.

As described at page 17, lines 4-7 of the specification, "when the light-emitting layer having a quantum well structure includes an impurity-doped well layer, forward voltage can be lowered". However, light of an undesirable wavelength may be emitted due to deterioration of the crystallinity by addition of the impurity.

For this reason, in order to obtain a gallium nitride compound semiconductor light-emitting device which emits light of a desired wavelength and which exhibits a low forward voltage, the light-emitting layer having a quantum well structure is effectively fabricated using well layers undoped with any impurity element and barrier layers doped with an impurity element, as recited in present claim 1.

Each of Hanaoka, Morita and Kaneyama fails to make up the noted deficiency of Yamada. None of Hanaoka, Morita and Kaneyama discloses or teaches a light-emitting layer constituted by a barrier layer doped with an impurity and a well layer undoped with any

impurity, which structure can bring about enhanced effects as compared to a light-emitting layer constituted by a well layer doped with an impurity.

In view of the foregoing, Applicants respectfully request reconsideration and withdrawal of the present §102 and §103 rejections of claims 1-2 and 5-17.

VI. Newly Added Claims

New claims 18-19 depend from claim 1. Thus, claims 18-19 are patentable for at least the reasons discussed above with respect to the patentability of independent claim 1.

Claims 18-19 are further patentable over Yamada in viewed of the cited references for the following reasons.

As recited in claims 18 and 19, when an impurity-doped GaN-based semiconductor exhibiting low resistance is used as the barrier layer of the light-emitting layer having a quantum well structure, the forward voltage can be lowered regardless of whether the layer joined to the contact layer or cladding layer is a barrier layer or a well layer.

In contrast, Yamada discloses that the well layers 108 and 109 may be undoped or doped with an acceptor impurity, such as Mg and Zn, or with a donor impurity, such as Si, and further that the well layers 108 and 109 may be doped with both the acceptor and donor impurities. Col. 10, lines 3-8.

Yamada does not disclose or suggest that a light-emitting layer constituted by a barrier layer doped with an impurity and a well layer undoped with any impurity can bring about the above-noted effects of the invention. In addition, Yamada does not disclose or teach any range of the concentration of the impurity to be contained in the barrier layer in the case where the

light-emitting layer is constituted by a barrier layer doped with an impurity and the well layer is undoped.

None of Hanaoka, Morita and Kaneyama discloses or teaches any range of the concentration of the impurity to be contained in the barrier layer in the case where the light-emitting layer is constituted by the barrier layer doped with an impurity and the well layer is undoped.

III. Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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